Space Weather Technical Forecast

Issued on Saturday, 12 February 2022 at 12:43 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Minor R1 Radio Blackout observed. Slight Chance of Minor G1 Geomagnetic Storms. Rising Chance of Active electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity rose to Moderate in the period, with an M1.4 observed from the vicinity of a new sunspot region at 12/0844UTC near the southwestern limb. This event was linked with both Type II and IV radio bursts, with an estimated speed of ejecta at 642km/s. X-ray flares were otherwise modest in size, with a few low C-class events well-spread between the groups occupying the western limb.

Figure 0: Clockwise from left: AIA 094 image showing the west limb M1.4 flare; GOES 16 X-ray flux (red trace); SIDC ROB time-integrated AIA 211 view of resultant dimming; and Humain observatory view of the Type II and IV radio sweeps.

There are currently four sunspot regions on the facing side of the sun, with two having recently disappeared from view. These groups include the largest on the disc - in the northwest, a mature Fai/Beta in the form of AR2941, with slight growth in its intermediate spots the main trend observed. In the southwestern quadrant, a pair of apparent Bxi/Beta groups were visible, firstly AR2946 and secondly the newly-developing region, likely responsible for the M-class flare. The proximity of the latter to the limb is likely to be masking detail from within the group. The final sunspot on the disc was AR2946 in the eastern solar hemisphere, with slight areal growth observed leading to Dso, perhaps now Dho/Beta classification.

The past 24 hours have seen numerous apparently minor Coronal Mass Ejections (CMEs) on coronagraph imagery. At the time of writing, none of these obviously have an Earth-directed component, appearing to emanate mostly in the rear-facing western quadrant. In particular, there is an absence of any westward-directed ejecta on STEREO A COR2 imagery (i.e. potentially in the

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Earth sector). Less certain is the possible filament eruption and dimming centred in the southeastern quadrant at 11/1200UTC, with a concurrent emission possibly generated in the northwest. Imagery is relatively scant, however there appear to be two well-separated CMEs heading east, and perhaps a western one too, although the source of this latter one may be from behind the western limb.

In addition to this uncertainty, there is the more recent M1.4 CME from the southwestern limb and the associated Type-II. An Earth-bound component from such a location appears unlikely, however this will be assessed once imagery becomes available. It remains to be seen whether any solar radiation storm results - the odds of this are rated at around 10% for S1.

At present then, no confirmed Earth-directed Coronal Mass Ejections (CMEs) were in evidence, but confidence is lower than average. Should imagery appear that counters this assessment, then updates will follow.

Solar Wind / Geomagnetic Activity: Solar winds, as measured DSCOVR at L1, showed a transition from the tail of the magnetic cloud from the 06 February CME ongoing since 09/2010UTC. This comprised the final part of the sinusoid which was strongly co-aligned with Earth's field, reaching 21nT Bt and +19nT Bz. This then underwent a discontinuity around 11/1800UTC and decline in magnitude before a coronal hole-like environment followed with a more typically small-scale and erratic IMF. The source of this apparent fast wind is uncertain, but is possibly the expected CH53/-, with the phi angle accordingly negative (towards the sun).

The solar wind speed underwent a succession of rises, from the low-400s of km/s to reach the upper 500s by the period's end. This was counter to the solar wind density, which fell from a high of 40ppcc to single figures ppcc in the fast wind. As stated, the IMF peaked at 21nT, with a range in north-south component from a protracted +19nT and a short-lived -16nT.

The net result of the above solar wind measures peaked at a provisional Active Kp4 in the 18-21 and 21-24UTC intervals, otherwise being largely Quiet.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 was at Background levels.

The high energy electron flux (greater than 2MeV) was initially above the High threshold, peaking at 6612pfu at 11/1705UTC, before geomagnetic activity resulted in near Background to Moderate levels for the remainder of the period.

The corresponding 24-hour integrated electron fluence values were near level, with an observation of 9.32e7 integrated pfu recorded at 12/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to remain Low through the next four days, but with a daily Slight Chance (20%) of M-class flares. Sunspot regions are expected to be in a state of flux in the period, with numerous departures and arrivals, and confidence is therefore low.

Solar Wind / Geomagnetic Activity: No CMEs feature in this forecast period, although confidence in this is somewhat lower than usual owing to imagery gaps. The current high speed stream is thought most likely to be the expected CH53, meaning that geomagnetic activity ought to peak with a Slight Chance of G1 on day one, Saturday 12 February, declining into the new working week.

Energetic Particles / Solar Radiation: High energy proton flux is most likely to remain at Background levels, but with a daily Slight Chance of S1. This risk peaks on day one given the M1.4

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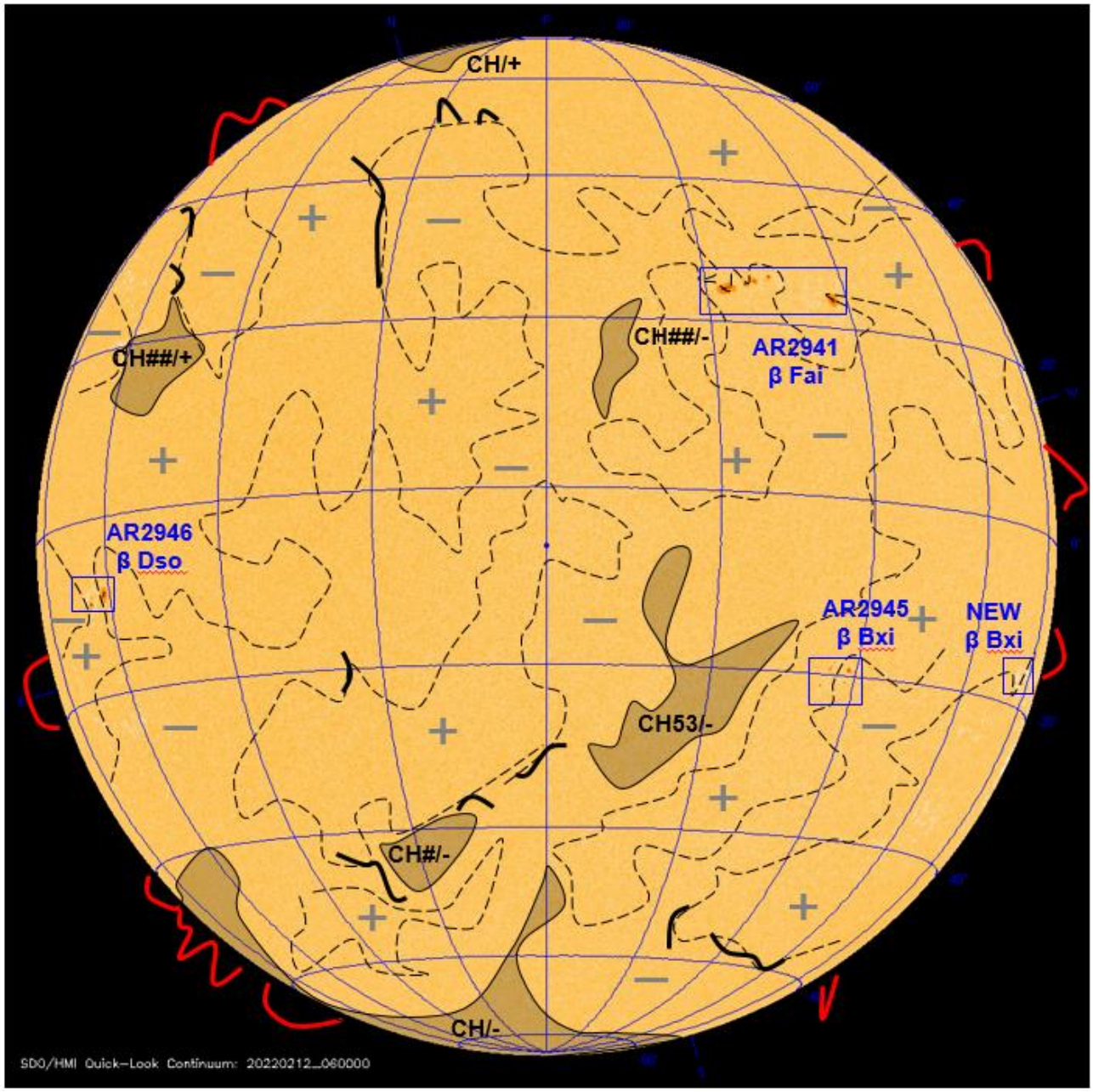
observed this UTC morning, with a 10% risk of S1, otherwise falling to 5% and further still into the new week as the crowded western limb depopulates.

The high energy electron forecast should initially maintain current levels, before showing a rising trend into the new working week following the high speed stream from CH53.

Figure 1. Solar Analysis Valid 12/0600UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No CMEs feature in this forecast at present, however confidence in this is somewhat lower than usual given numerous (particularly westward) CMEs with imagery gaps hampering analysis. The M1.4 CME is thought unlikely to have an Earth-directed component, however has yet to be analysed.

Earth now appears to have segued from the tail of the 06 February CME (ongoing since 09/2010UTC) into a CIR and then coronal hole-like environment. The cause of this is thought most likely to be CH53, which is similar to persistence; the arrival time suggested by recent STEREO A measurements; and Enlil's thoughts, which all implied Friday UTC evening as most probable. This runs counter to its apparent position on the disc, which looks visually too far eastward, however there may be some EUV flux masking any westward extension.

This means that geomagnetic activity may have already peaked for the four-day period, with no further fast wind features expected, although there is the caveat that recent minor transients may pollute the forecast, lowering confidence. There is a Slight Chance of G1 over the UTC weekend, falling with time, with Unsettled and then Quiet conditions restored into the new week.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

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Figure 2: The past 72 hours in solar wind data at L1, showing (from top to bottom) IMF and its components; solar wind speed; solar wind density. Note especially the 06 February CME arrival around 09/2010UTC, the magnetic cloud-like signature between 10/1200UTC and 11/1000UTC, the discontinuity at the tail end of the magnetic cloud and intensification (perhaps a second shock) at 11/1000UTC, and the evolution into a coronal hole-like environment by 11/2200UTC.

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Radio Blackouts - X-Ray Flares:

The balance of sunspot groups should enter a state of flux over the forecast period. Returning regions Ex-2935 and Ex-2934 should begin to rotate onto the visible disc by the end of the UTC weekend and into the new working week respectively, with both appearing on far-side soundings and EUV imagery, suggesting at least some survival(s) here. This is in contrast to the depopulation expected to occur of the current western limb. This is all happening in the context of a changing disc, with an as yet unnumbered region likely to have produced the most significant event of the period, despite its apparent lowly Bxi/Beta classification.

The X-ray forecast on balance maintains a daily Slight Chance of M-class flares, however this may be revised downwards should the eastern horizon spots fall short of expectations as the western limb quietens down.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	20	20	20	20
Very Active	R3 to R5 X Class	No	2	2	2	2

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux may yet respond at GOES 16 to this morning's M1.4 flare, with similar past events offering a roughly 10% chance of S1 in the ensuing hours. Given there has been a significant flare, this risk represents the peak of the period, otherwise falling with time as the western limb sunspots more comfortably distance themselves from this geoeffective position and continue onto the far side.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	10	5	5	2
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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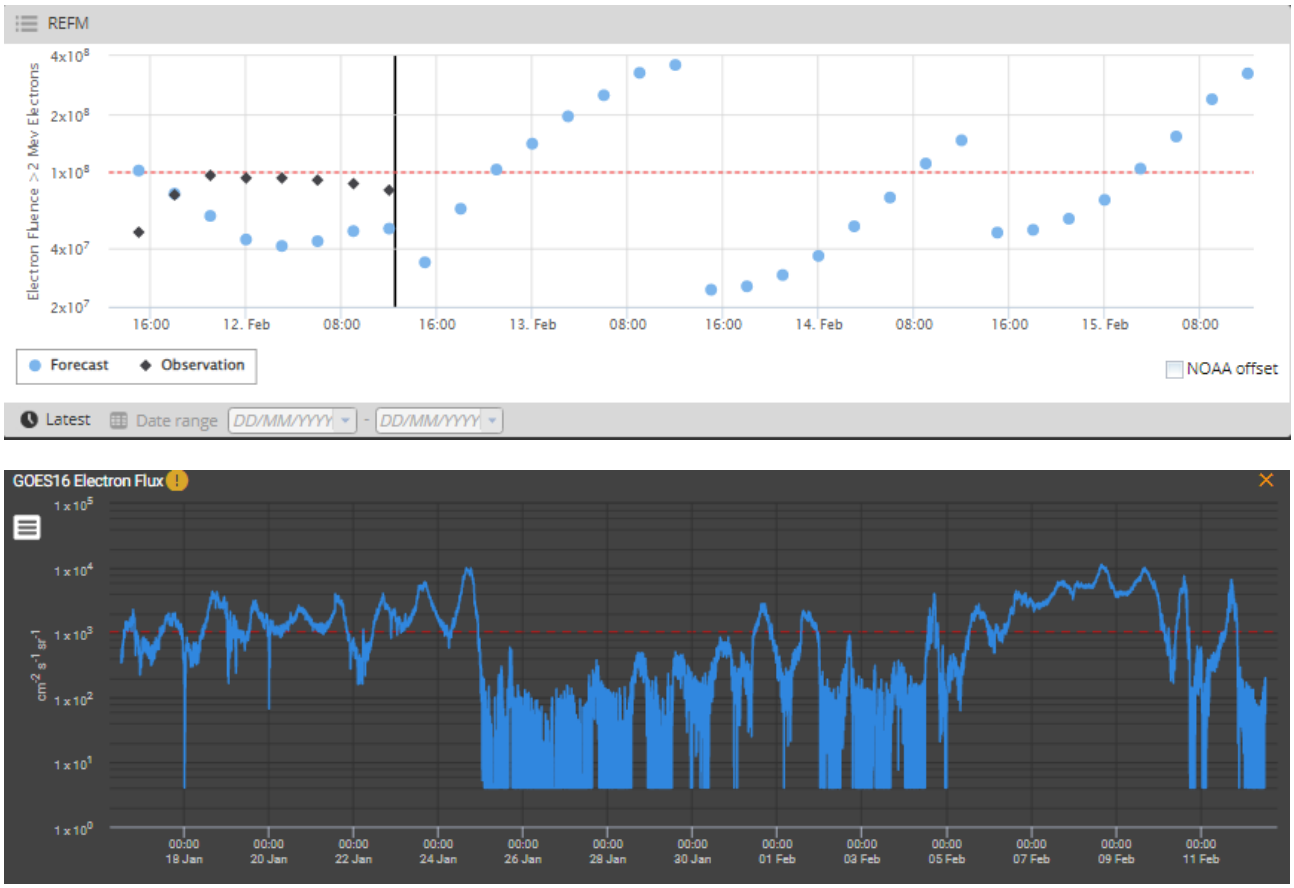
High Energy Electrons Event (≥ 2MeV):

Confidence in the electron forecast is now rising, with the current coronal hole fast wind so far proving similar on this pass to last rotation, now assumed to be CH53. This feature's predecessor saw eventual marginal excedence of the Active 24-hour integrated fluence threshold.

This gives a rising probability of exceedence of Active from current levels in the four-day period, with the caveat of minor transient activity perhaps polluting the forecast later in the four days.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	40	60	70	70
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 3: MOSWOC REFM and fluence forecast (top), showing reactionary rising trend in forecast period; and 27-day GOES 16 high energy electron flux, with High flux seen on last pass of the current fast wind feature, leading eventually to Active fluence. Similar is expected on this occasion.



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